

PRELIMINARY DATA SUMMARY

January 1989

U.S. Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
Field Research Facility
Duck, North Carolina

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CERC Field Research Facility
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

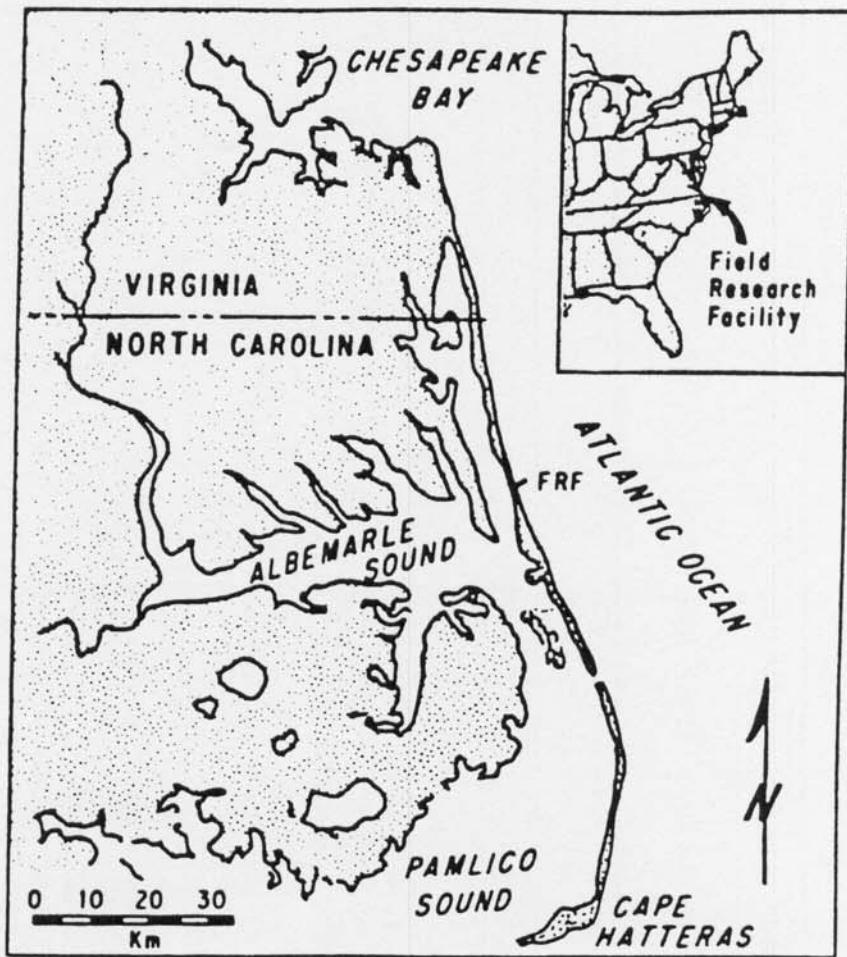


Figure 1. FRF location map

Table 1: Instrument Status/Data Availability

JAN 1989

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

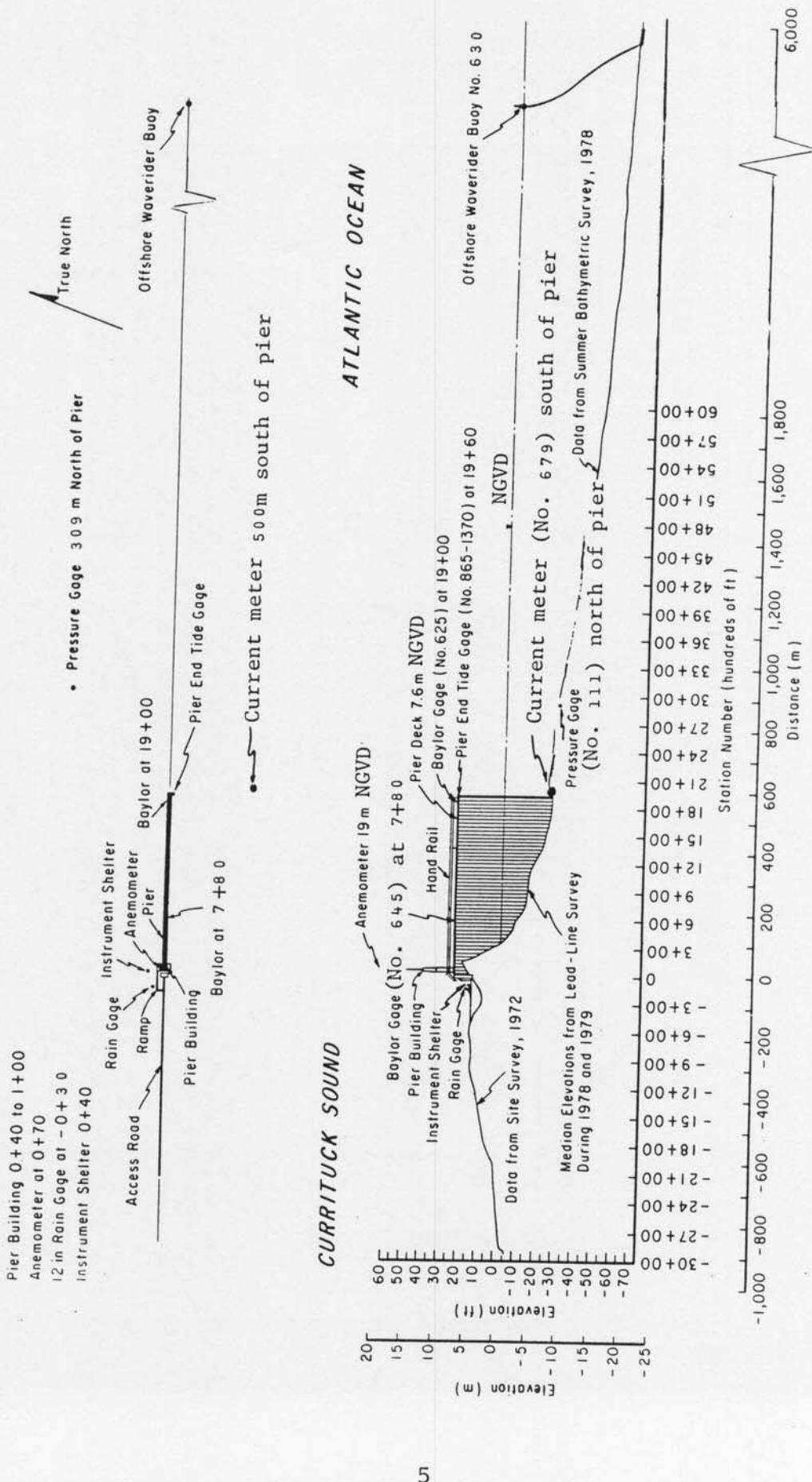


Figure 2. Instrument locations at FRF

PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured on top of the laboratory building at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

Table 2: Meteorological Data

Jan 1989

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	6	17	8.4	1018.6	0
	700	10	45	8.9	1015.9	3
	1300	4	246	11.6	1010.8	5
	1900	7	325	7.3	1014.2	0
2	100	6	321	5.8	1014.5	0
	700	6	289	5.3	1015.5	0
	1300	6	248	7.9	1014.2	0
	1900	4	203	7.2	1013.8	0
3	100	7	233	6.5	1012.1	0
	700	4	246	6.8	1011.4	0
	1300	4	136	8.7	1006.0	0
	1900	4	281	6.6	996.2	5
4	100	12	294	5.0	998.6	0
	700	12	318	3.0	1007.7	0
	1300	10	317	3.9	1011.8	0
	1900	7	325	1.6	1018.2	0
5	100	11	347	0.2	1020.3	0
	700	4	298	-2.2	1022.3	0
	1300	2	247	2.8	1021.6	0
	1900	3	172	1.9	1021.9	0
6	100	3	172	4.9	1020.6	0
	700	8	113	7.3	1016.9	2
	1300	5	210	9.5	1012.1	5
	1900	5	244	9.2	1014.5	0
7	100	5	4	7.9	1017.5	0
	700	8	6	5.5	1020.9	0
	1300	5	356	6.9	1023.3	0
	1900	3	30	7.2	1023.6	0
8	100	2	291	7.0	1020.9	0
	700	4	187	9.6	1019.2	0
	1300	6	193	18.7	1016.5	0
	1900	6	201	15.2	1016.9	0
9	100	5	296	13.2	1019.2	0
	700	7	316	9.4	1021.9	0
	1300	5	16	6.3	1024.3	0
	1900	7	31	6.3	1027.4	0
10	100	9	26	5.9	1028.7	0
	700	10	30	5.2	1030.4	0
	1300	4	50	7.7	1028.0	8
	1900	5	9	7.6	1029.4	0
11	100	1	280	5.9	1028.7	0
	700	5	15	5.0	1031.8	0
	1300		Hardware Error			0
	1900	6	52	8.1	1032.4	0
12	100	7	60	8.9	1028.4	0
	700	5	129	9.5	1024.0	0
	1300	7	241	13.7	1018.9	9
	1900	5	208	10.9	1019.6	0
13	100	7	213	11.2	1016.5	0
	700	6	242	11.2	1016.9	0
	1300	13	356	4.8	1022.6	8
	1900	13	355	4.9	1029.7	0
14	100	9	27	3.8	1032.1	0
	700	4	61	5.2	1033.5	0
	1300	7	42	6.9	1030.4	0
	1900	8	90	8.6	1026.0	0
15	100	5	179	13.4	1020.9	0
	700	6	182	14.4	1017.5	2
	1300	7	249	13.1	1016.5	0
	1900	4	232	11.1	1015.5	0
16	100	3	319	10.2	1014.5	0
	700	4	342	8.1	1014.2	0
	1300	10	351	7.0	1017.9	0
	1900	4	22	6.0	1021.9	0

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Jan 1989

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed m/sec	Direction deg TN	deg C	Pressure mb	mm
17	100	2	252	3.7	1023.3	0
	700	3	221	3.2	1024.0	0
	1300	4	241	10.0	1022.3	0
	1900	3	212	6.9	1021.9	0
18	100	2	211	4.9	1021.9	0
	700	3	238	4.9	1021.3	0
	1300	3	244	11.0	1017.5	0
	1900	3	186	6.9	1014.8	0
19	100	7	242	8.2	1012.8	0
	700	5	255	7.3	1016.9	0
	1300	4	234	13.6	1017.9	0
	1900	3	175	8.8	1018.6	0
20	100	3	202	9.2	1016.2	0
	700	4	202	9.7	1013.1	0
	1300	9	236	12.9	1008.1	0
	1900	7	286	11.0	1011.8	0
21	100	8	294	5.7	1017.5	0
	700	10	325	1.2	1024.3	0
	1300	12	347	2.7	1028.0	0
	1900	9	15	1.8	1030.1	0
22	100	6	47	3.2	1030.1	0
	700	8	34	4.6	1029.1	0
	1300	6	35	7.8	1026.0	0
	1900	8	26	8.0	1023.3	0
23	100	11	24	8.9	1019.9	0
	700	11	19	9.3	1018.6	0
	1300	12	356	8.7	1016.2	0
	1900	10	351	7.8	1016.9	0
24	100	7	341	6.9	1017.2	0
	700	4	323	4.6	1019.2	0
	1300	3	349	10.7	1018.9	0
	1900	3	229	5.9	1019.6	0
25	100	2	259	6.8	1020.3	0
	700	1	196	3.8	1022.3	0
	1300	5	10	10.0	1024.3	0
	1900	6	29	8.4	1027.0	0
26	100	4	49	8.4	1026.7	0
	700	5	128	9.3	1025.0	0
	1300	6	238	15.8	1020.6	0
	1900	6	198	15.9	1016.5	0
27	100	8	223	14.8	1011.8	0
	700	5	245	10.9	1012.8	0
	1300	2	101	12.6	1013.5	0
	1900	2	122	8.2	1017.5	0
28	100	7	5	8.4	1020.6	0
	700	7	37	7.5	1024.7	0
	1300	1	28	10.2	1024.7	0
	1900	3	155	5.9	1023.0	0
29	100	3	188	7.9	1021.6	0
	700	6	221	8.7	1020.3	0
	1300	6	237	16.0	1018.2	0
	1900	3	184	13.2	1017.5	0
30	100	5	216	12.8	1015.2	0
	700	7	212	13.4	1012.1	0
	1300		Hardware Error		0	
	1900	9	233	15.9	1004.7	0
31	100	6	326	9.3	1008.4	4
	700	6	3	7.4	1015.2	0
	1300	5	120	10.5	1014.2	0
	1900		Hardware Error		0	
		Resulant 2	324	Mean 8.1	Mean 1019.4	Total 51

(Sheet 2 of 2)

PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all H_{mo} and T_p values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Jan 1989

Day	Hour	645		625		111		630	
		Baylor at 7+80	Hmo,m T,sec	Baylor at 19+00	Hmo,m T,sec	Pressure Gage	Hmo,m T,sec	Offshr Wvrdr	Hmo,m T,sec
1	0100	0.33	3.77			0.42	9.14	0.51	8.83
	0700	0.82	4.92			1.32	5.33	1.45	5.12
	1300	1.11	6.40			1.31	5.95	1.62	6.01
	1900	0.87	7.11			1.85	7.76	1.98	7.31
2	0100	1.09	8.26			1.81	8.00	1.89	8.00
	0700	0.88	11.13			1.56	8.83	1.50	8.83
	1300	*				1.37	10.67	1.16	7.11
	1900	*				0.83	9.14	0.82	8.00
3	0100	*				0.76	10.67	0.76	8.53
	0700	*				0.56	9.48	0.52	8.83
	1300	0.29	9.85			0.54	9.14	0.47	9.85
	1900	0.43	4.83			0.56	9.14	0.69	8.83
4	0100	0.66	3.94			0.86	3.77	1.37	4.57
	0700	1.19	6.92			1.92	6.92	2.48	6.92
	1300	1.02	7.53			2.07	7.11	2.45	8.26
	1900	1.04	8.83			1.77	7.76	2.11	8.26
5	0100	0.94	9.85			1.81	9.85	1.90	6.92
	0700	1.06	11.64			1.46	10.67	1.50	10.67
	1300	0.94	14.22			1.56	13.47	1.54	13.47
	1900	0.97	14.22			1.35	14.22	1.35	13.47
6	0100	0.79	14.22			1.12	13.47	1.17	14.22
	0700	0.58	14.22			0.95	14.22	0.92	14.22
	1300	0.64	13.47			0.99	13.47	0.95	13.47
	1900	0.42	13.47			0.83	12.80	0.84	12.80
7	0100	0.40	11.64			0.70	12.19	0.79	9.48
	0700	0.61	9.85			0.81	11.13	0.96	10.24
	1300	0.83	9.48			0.96	9.48	1.14	8.83
	1900	0.75	9.14			1.04	8.83	1.08	8.83
8	0100	0.86	10.67			0.97	10.24	1.08	10.24
	0700	0.73	9.85			1.00	9.48	1.10	9.14
	1300	0.66	9.85			0.87	9.48	0.97	9.85
	1900	0.49	10.67			0.81	10.24	0.96	9.85
9	0100	0.47	10.67	Gage Inoperative		0.65	10.67	0.75	10.24
	0700	0.34	10.67			0.60	10.67	0.73	10.67
	1300	0.57	3.66			0.64	9.85	0.69	4.06
	1900	0.60	4.74			0.75	4.92	0.89	4.92
10	0100	0.64	5.57			1.02	5.82	1.07	5.57
	0700	0.81	4.74			1.09	4.66	1.22	4.92
	1300	0.85	5.69			1.18	5.57	1.32	14.08
	1900	0.72	5.57			0.95	5.33	1.08	5.12
11	0100	0.63	4.83			0.84	8.26	0.92	5.22
	0700	0.56	6.74			0.88	6.92	1.07	6.40
	1300			Hardware Error					
	1900	0.54	3.82			0.84	7.11	0.99	6.40
12	0100	0.82	5.45			1.24	5.82	1.36	5.69
	0700	0.85	5.95			1.29	6.56	1.56	5.95
	1300	0.90	8.26			1.76	8.26	2.44	8.26
	1900	0.77	6.74			1.26	8.26	1.50	8.53
13	0100	0.61	7.31			0.89	6.74	1.17	8.26
	0700	0.44	5.57			0.75	8.83	0.90	7.53
	1300	1.03	5.02			1.66	5.22	1.66	5.57
	1900	0.90	6.40			1.91	6.74	2.21	6.74
14	0100	1.11	6.56			1.49	6.56	1.61	6.56
	0700	0.74	5.69			1.15	7.76	1.30	7.11
	1300	0.75	5.57			1.00	7.76	1.14	7.53
	1900	0.73	5.12			0.99	6.74	1.24	6.74
15	0100	0.62	5.02			0.98	5.12	1.19	5.95
	0700	0.62	6.74			0.99	7.31	1.32	6.74
	1300	0.54	6.74			0.90	6.24	1.54	6.92
	1900	0.40	9.85			0.72	7.11	0.96	6.92
16	0100	0.38	7.31			0.64	9.85	0.86	6.74
	0700	0.29	7.31			0.55	10.24	0.71	7.53
	1300	0.87	4.41			1.06	4.41	1.19	4.83
	1900	0.77	5.45			0.92	5.45	1.10	5.69

* Electronic problems

(Continued)

Table 3: Wave Data

Jan 1989

Day	Hour	645		625		111		630	
		Baylor	at 7+80	Baylor	at 19+00	Pressure	Gage	Offshir	Wvrdr
		Hmo,m	T,sec	Hmo,m	T,sec	Hmo,m	T,sec	Hmo,m	T,sec
17	0100	0.57	5.02			0.73	5.45	0.85	5.95
	0700	0.48	5.57			0.74	8.26	0.80	8.83
	1300	0.33	5.12			0.69	7.76	0.71	8.53
	1900	0.20	9.48			0.50	9.14	0.52	9.48
18	0100	0.18	9.48			0.44	9.48	0.52	9.48
	0700	0.17	10.24			0.41	9.14	0.44	9.48
	1300	0.18	10.24			0.38	9.48	0.49	9.85
	1900	0.17	9.85			0.40	9.85	0.46	9.14
19	0100	0.13	9.14			0.35	9.14	0.50	8.83
	0700	0.13	10.24			0.27	9.85	0.34	9.48
	1300	0.18	3.08			0.28	9.48	0.28	9.48
	1900	0.14	9.48			0.30	9.48	0.33	8.83
20	0100	0.13	9.14			0.30	8.83	0.32	9.14
	0700	0.16	9.85			0.29	7.76	0.33	9.14
	1300	0.10	17.07			0.26	9.14	0.42	2.37
	1900	0.23	2.69			0.29	3.41	0.63	3.12
21	0100	0.89	5.22			0.94	5.33	1.41	5.02
	0700	1.31	6.92			1.94	6.40	2.17	6.92
	1300	0.88	6.56			1.65	6.24	1.99	6.40
	1900	1.04	6.09			1.29	6.40	1.44	6.09
22	0100	0.72	7.53			1.13	7.53	1.25	5.95
	0700	0.81	6.56			0.93	6.74	1.02	7.31
	1300	0.69	4.83			1.01	5.12	1.11	6.24
	1900	0.73	5.82			1.03	5.02	1.12	4.83
23	0100	0.83	5.95			1.29	5.45	1.35	5.69
	0700	1.10	4.74			2.03	6.74	2.29	6.56
	1300	0.86	10.67			2.75	10.24	2.78	11.13
	1900	1.13	11.64			2.89	11.64	2.86	11.13
24	0100	0.94	11.13			2.80	11.64	2.66	10.67
	0700	1.21	11.64			2.55	11.13	2.63	11.13
	1300	1.09	10.67			2.03	11.13	1.85	11.13
	1900	1.07	11.13			1.93	11.13	1.88	10.67
25	0100	1.04	11.13			1.48	11.13	1.40	9.85
	0700	0.75	9.85			1.25	10.24	1.15	9.48
	1300	0.72	10.24			1.08	10.24	0.98	9.48
	1900	0.70	9.48			1.11	9.14	1.17	9.48
26	0100	0.93	6.40			1.28	6.56	1.33	6.24
	0700	0.89	6.40			1.26	6.74	1.28	7.11
	1300	0.78	7.11			1.21	8.00	1.23	7.53
	1900	0.68	8.26			1.08	8.26	1.15	8.26
27	0100	0.57	9.14			0.86	9.48	1.06	7.53
	0700	0.47	6.92			0.67	6.92	0.83	6.92
	1300	0.33	15.06			0.50	16.00	0.50	15.01
	1900	0.34	14.22			0.50	15.06	0.52	15.06
28	0100	0.38	15.06			0.54	15.06	0.58	9.85
	0700	0.77	5.95			1.04	5.82	1.11	5.82
	1300	0.64	6.09			0.87	5.82	1.08	6.09
	1900	0.52	6.09			0.73	6.09	0.77	6.09
29	0100	0.36	5.02			0.58	9.14	0.57	9.48
	0700	0.29	9.85			0.49	8.26	0.52	7.31
	1300	0.23	9.85			0.39	10.24	0.42	10.24
	1900	0.23	9.85			0.36	10.24	0.38	9.85
30	0100	0.21	10.67			0.35	10.67	0.41	10.24
	0700	0.23	10.24			0.33	9.85	0.38	9.85
	1300								Hardware Error
	1900	0.27	9.85			0.38	6.92	0.47	7.31
31	0100	0.38	8.26			0.42	7.31	0.70	3.33
	0700	0.61	4.20			0.77	4.27	0.96	4.34
	1300	0.42	4.74			0.56	4.92	0.62	5.12
	1900								Hardware Error
Mean		0.64	8.17	0.00	0.00	1.02	8.50	1.13	8.16
Std dev		0.30	3.02	0.00	0.00	0.56	2.56	0.58	2.53

* Electronic problems

(Sheet 2 of 2)

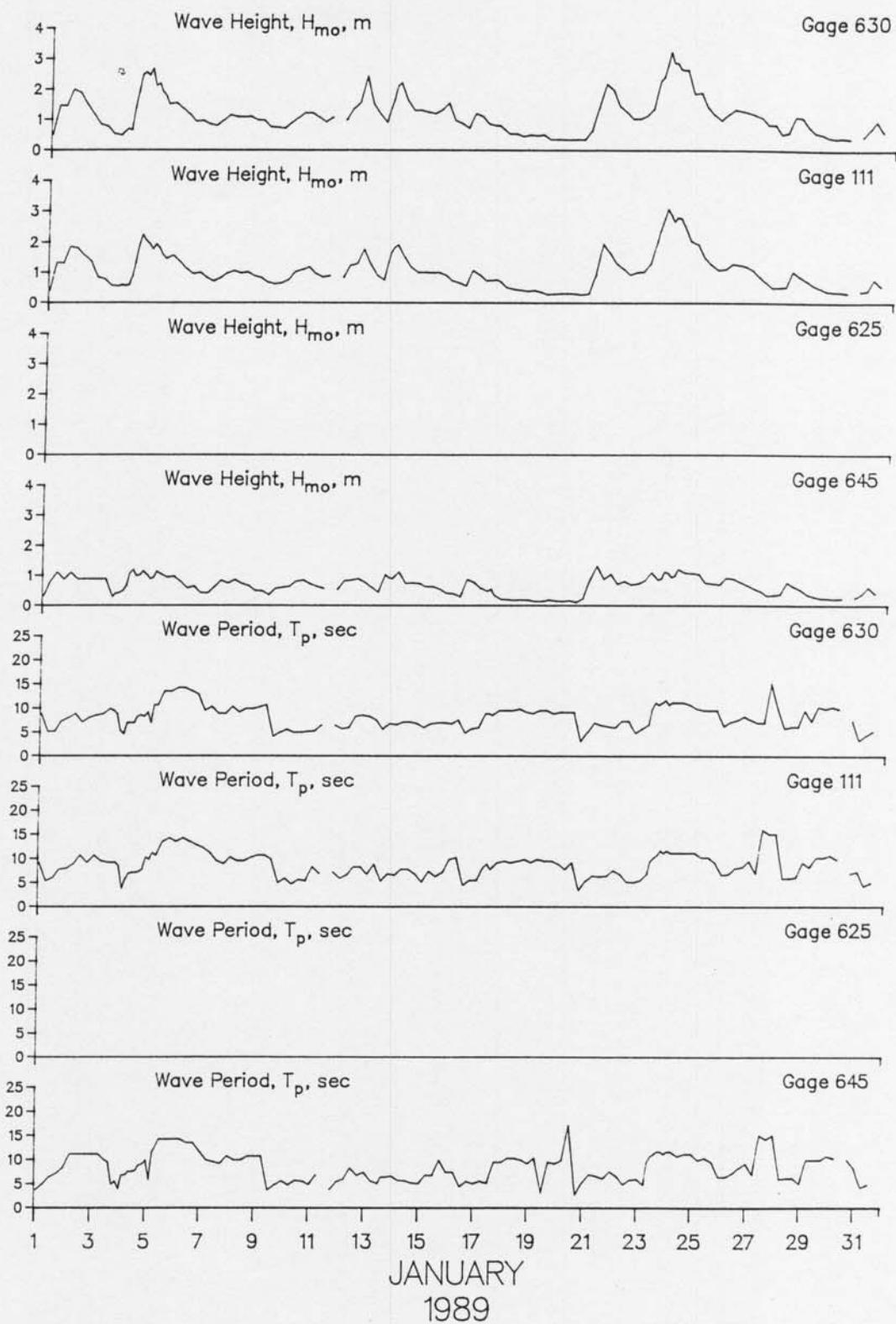


Figure 3. Time history of wave heights and periods

PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data
Jan 1989

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
		Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	619m Offshore Depth -4.8m (NGVD) ID #679
1 0100	Along									Speed Dir
1 0700	Along	7 S	55	S		23	S	7	S	1 N
	Cross	0 off	189	3 on		North		3	off	2 off
	Result	7 160	55	163				8	137	2 43
1 1300	Along									8 S
	Cross									0
	Result									8 160
1 1900	Along									28 S
	Cross									4 off
	Result									28 152
2 0100	Along									20 S
	Cross									3 off
	Result									20 151
2 0700	Along	22 S	87	S		59	S	13	S	7 off
	Cross	7 off	177	13		North		1	off	13 156
	Result	23 143	88	151				13		8 S
2 1300	Along									1 off
	Cross									8 153
	Result									8 S
2 1900	Along									2 off
	Cross									8 146
	Result									2 S
3 0100	Along									2 on
	Cross									3 205
	Result									5 S
3 0700	Along	11 S	17	N		13	S	2	off	3 on
	Cross	3 on	152	4		North		5	138	17
	Result	11 177	17	354				5		2 S
3 1300	Along									5 off
	Cross									6 109
	Result									1 S
3 1900	Along									2 off
	Cross									2 97
	Result									14 S
4 0100	Along									0
	Cross									14 160
	Result									14 off
4 0700	Along	87 S	87	S		131	S	33	S	0 off
	Cross	0 off	177	9 off		North		4	off	33 153
	Result	87 160	88	154				33		31 S
4 1300	Along									5 off
	Cross									31 151
	Result									28 S
4 1900	Along									4 off
	Cross									28 152
	Result									32 S
5 0100	Along									4 off
	Cross									32 153
	Result									32 S
5 0700	Along	29 S	36	S		64	S	17	S	15 off
	Cross	15 off	165	11 on		North		3	off	17 150
	Result	32 133	37	177				17		7 S
5 1300	Along									5 off
	Cross									9 124
	Result									0 off
5 1900	Along									1 off
	Cross									1 70
	Result									

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)
Jan 1989

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter			
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
6 0100	Along Cross Result										13	N
6 0700	Along Cross Result	44	N			36	N		49	N	4	on
		7	on		152	0	off			South	14	323
		44	331			36	340				2	on
6 1300	Along Cross Result										14	332
6 1900	Along Cross Result										8	N
											3	on
											9	319
7 0100	Along Cross Result										3	S
											2	on
											4	194
7 0700	Along Cross Result	29	S			8	S		23	S	12	S
		4	off		152	3	on			North	7	off
		29	151			9	182				14	130
7 1300	Along Cross Result										16	S
7 1900	Along Cross Result										4	off
											13	142
8 0100	Along Cross Result										14	139
											8	S
											4	off
											9	133
8 0700	Along Cross Result	8	N			17	N		61	S	7	S
		2	off		152	3	on			South	5	off
		8	354			18	331				9	124
8 1300	Along Cross Result										4	S
8 1900	Along Cross Result										3	off
											5	123
9 0100	Along Cross Result										9	N
											1	on
											5	329
9 0700	Along Cross Result	22	S			47	S		48	S	8	N
		5	on		140	19	on			North	1	on
		22	174			51	182				8	333
9 1300	Along Cross Result										7	S
9 1900	Along Cross Result										3	off
											8	137
10 0100	Along Cross Result										0	
											3	off
											3	70
10 0700	Along Cross Result	9	N			25	S		33	S	6	S
		7	on		177	0				North	4	off
		11	303			25	160				7	126
10 1300	Along Cross Result										5	N
10 1900	Along Cross Result										2	off
											5	
											3	33
											1	on
											3	322

KEY = All speeds in cm/sec
N = Northward, Shore parallel
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on = onshore off = offshore

Table 4: Current Data (Continued)
Jan 1989

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter	
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed
11 0100-Along Cross Result										619m Offshore Depth -4.8m (NGVD) ID #679
11 0700-Along Cross Result	29 S 3 on 29 166				13 S 6 on 15 187			116 N South		6 S 4 off 7 126
11 1300-Along Cross Result										
11 1900-Along Cross Result										5 S 6 off 8 110
12 0100-Along Cross Result										10 S 8 off
12 0700-Along Cross Result	14 N 4 on 15 323				68 N 14 on 69 329			55 N South		6 N 0 6 340
12 1300-Along Cross Result										2 S 2 on 3 205
12 1900-Along Cross Result										2 N 1 on 2 313
13 0100-Along Cross Result										6 N 0 6 340
13 0700-Along Cross Result	4 N 8 on 9 277				41 N 12 on 42 323			17 N South		9 N 1 on 9 334
13 1300-Along Cross Result										22 S 6 off 23 145
13 1900-Along Cross Result										33 S 6 off 34 150
14 0100-Along Cross Result										22 S 7 off 23 142
14 0700-Along Cross Result	22 S 3 on 22 169				23 S 3 on 23 169			38 S North		7 S 7 off 10 115
14 1300-Along Cross Result										6 S 5 off 8 120
14 1900-Along Cross Result										0 4 off 4 70
15 0100-Along Cross Result										1 S 2 on 2 223
15 0700-Along Cross Result	5 S 2 off 5 141				10 N 8 on 13 303			6 S South		2 N 1 on 2 313
15 1300-Along Cross Result										3 N 1 on 3 322
15 1900-Along Cross Result										0 4 off 4 70

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on = onshore off = offshore

Table 4: Current Data (Continued)
Jan 1989

Alongshore Cross-shore Resultant	Pier Measurements						Beach Measurements			Current Meter	
	Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface)				(500m Updrift)		619m Offshore Depth -4.8m (NGVD)		
Day	Time	Speed	Dir	Distance (m)		Speed	Dir	Location	Speed	Dir	ID #679
16	0100-Along Cross Result								6	N	
									4	off	
									7	14	
16	0700-Along Cross Result	16	N			61	N		3	N	
		14	off	189		6	on		3	off	
		22	22			61	334		4	25	
16	1300-Along Cross Result								16	S	
									3	off	
									16	149	
16	1900-Along Cross Result								11	S	
									3	off	
									11	145	
17	0100-Along Cross Result								1	S	
									3	off	
									3	88	
17	0700-Along Cross Result	22	S			41	S		4	S	
		7	on	177		14	on		4	off	
		23	177			43	179		6	115	
17	1300-Along Cross Result								5	N	
									1	off	
									5	351	
17	1900-Along Cross Result								4	N	
									1	on	
									4	326	
18	0100-Along Cross Result								9	N	
									0		
									9	340	
18	0700-Along Cross Result	8	N			34	N		6	N	
		4	off	162		25	off		0		
		9	7			42	17		6	340	
18	1300-Along Cross Result								6	N	
									0		
									6	340	
18	1900-Along Cross Result								3	N	
									0		
									3	340	
19	0100-Along Cross Result								3	N	
									1	on	
									3	322	
19	0700-Along Cross Result	3	N			6	S		1	N	
		10	off	146		3	on		0		
		10	52			6	187		1	340	
19	1300-Along Cross Result								2	N	
									1	off	
									2	7	
19	1900-Along Cross Result								4	N	
									4	off	
									6	25	
20	0100-Along Cross Result								3	N	
									1	on	
									3	322	
20	0700-Along Cross Result	44	N			20	N		5	N	
		9	off	134		30	off		2	off	
		44	351			37	36		5	2	
20	1300-Along Cross Result								2	N	
									3	on	
									4	284	
20	1900-Along Cross Result								8	S	
									0		
									8	160	

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Table 4: Current Data (Continued)
Jan 1989

Alongshore Cross-shore Resultant Time	Pier Measurements						Beach Measurements			Current Meter	
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
Day											
21 0100-Along Cross Result										10	S
										2	off
										10	149
21 0700-Along Cross Result	203	S			305	S		43	S	28	S
	30	on		0	91	on				4	off
	205	169			318	177				28	152
21 1300-Along Cross Result										28	S
										5	off
										28	150
21 1900-Along Cross Result										18	S
										4	off
										18	147
22 0100-Along Cross Result										8	S
										4	off
										9	133
22 0700-Along Cross Result	7	S			16	S		55	S	2	N
	2	on		174	8	on				3	off
	8	174			18	187				4	36
22 1300-Along Cross Result										6	N
										2	off
										6	358
22 1900-Along Cross Result										4	N
										2	off
										4	7
23 0100-Along Cross Result										13	S
										4	off
										14	143
23 0700-Along Cross Result	23	S			23	N		64	N	11	S
	23	on		165	47	on				2	on
	32	205			52	277				11	170
23 1300-Along Cross Result										10	S
										6	off
										12	129
23 1900-Along Cross Result										9	S
										16	off
										18	99
24 0100-Along Cross Result										8	S
										10	off
										13	109
24 0700-Along Cross Result	61	S			51	N		27	S	4	S
	3	on		201	25	on				14	off
	61	163			57	313				15	86
24 1300-Along Cross Result										6	S
										7	off
										9	111
24 1900-Along Cross Result										8	S
										0	
										8	160
25 0100-Along Cross Result										8	S
										5	off
										9	128
25 0700-Along Cross Result	30	S			32	N		58	N	0	
	3	off		177	19	off				4	off
	31	154			37	11				4	70
25 1300-Along Cross Result										9	S
										4	off
										10	136
25 1900-Along Cross Result										17	S
										5	off
										18	144

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Table 4: Current Data (Continued)
Jan 1989

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter	
	Dye at (579 m) (surface)	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
26 0100-Along Cross Result										
26 0700-Along Cross Result	11 2 11	S off 151		0 2 2	off 70			6 S	14 0 14	S
26 1300-Along Cross Result									10 3 10	S off 143
26 1900-Along Cross Result									1 2 2	S on 223
27 0100-Along Cross Result									4 3 5	N
27 0700-Along Cross Result	6 12 13	N off 43		44 48 65	N on 292			5 N	8 3 9	N on 303
27 1300-Along Cross Result									10 5 11	N off 7
27 1900-Along Cross Result									10 5 11	N on 313
28 0100-Along Cross Result									2 2 3	N off 25
28 0700-Along Cross Result	7 3 8	S off 133		55 0 55	S 180 160			49 S	6 3 7	S off 133
28 1300-Along Cross Result									5 5 7	S off 115
28 1900-Along Cross Result									3 2 4	N off 14
29 0100-Along Cross Result									0 0 0	
29 0700-Along Cross Result	6 10 12	N off 40		22 1 22	N off 343			21 N	1 0 1	N
29 1300-Along Cross Result									6 1 6	N on 331
29 1900-Along Cross Result									5 1 5	N on 329
30 0100-Along Cross Result									4 1 4	N on 326
30 0700-Along Cross Result	25 15 30	N off 11		25 8 27	N off 357			0	6 3 7	N on 313
30 1300-Along Cross Result										
30 1900-Along Cross Result									2 3 4	N on 284

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 on = onshore off = offshore

Table 4: Current Data (Concluded)
Jan 1989

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter	
	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	Speed
31 0100-Along Cross Result										7 S
31 0700-Along Cross Result	10 3	S on	152	55 83	S on	59	S North			9 S
31 1300-Along Cross Result	11	177		100 216						1 off
31 1900-Along Cross Result										9 154
										5 N
										1 off
										5 351

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PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Jan 1989

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End		
		Primary	Secondary			Temp.,C	Density g/cc	Secchi Vis.,m
1	0915	60		35	57	8.4	1.0258	1.8
2	0705	50		70	29	7.8	1.0252	1.5
3	0950	85			14	8.0	1.0256	1.5
4	0715	35		30	35	6.1	1.0254	0.9
5	0705	55		65	27	5.3	1.0247	1.5
6	0715	95		75	24	7.0	1.0250	1.8
7	0845	50	90	65	73	7.2	1.0252	1.8
8	0850	80	10		41	8.4	1.0248	1.8
9	0850	25		65	18	7.2	1.0246	1.5
10	0912	65	35	65	98	7.0	1.0244	0.9
11	0855	90	20	20	43	7.2	1.0246	2.1
12	0822	80		85	152	8.3	1.0244	2.4
13	0836	115			46	8.4	1.0250	1.8
16	1016	20		65	26	7.5	1.0252	1.2
17	0815	60			21	7.0	1.0242	5.2
15	0908	100			137	8.6	1.0252	1.8
14	0843	55		60	126	6.5	1.0244	1.2
18	0815	90			30	7.2	1.0245	4.6
19	0828	5			12	8.1	1.0250	3.0
20	0810	none visible			12	8.1	1.0252	2.1
21	0814	10		20	122	6.6	1.0262	0.3
22	0844	30		40	104	6.7	1.0257	1.8
23	0815	80		85	122	7.5	1.0260	0.9
24	0740	90	120	80	191	6.9	1.0252	0.9
25	0750	80		80	134	7.3	1.0238	2.1
26	0718	60	35	60	98	7.2	1.0238	1.2
27	0747	none visible			24	8.4	1.0252	1.8
28	0830	30		55	101	7.8	1.0248	2.1
29	0825	60			6	7.8	1.0250	2.1
30	0758	none visible			18	8.9	1.0260	1.8
31	0800	10			12	8.4	1.0258	3.0

PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

FRF Tide Heights
Jan 1989

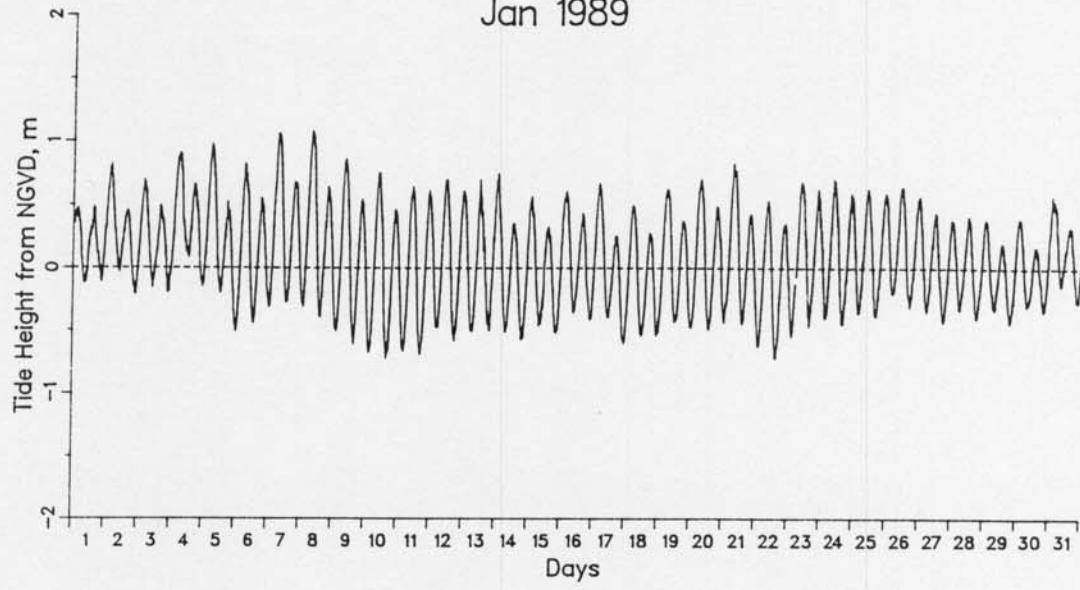


Figure 4. Water level time history

Monthly Water Levels, m NGVD

Extreme Low = -0.72 on day 10 at 1512 hr
Extreme High = 1.08 on day 8 at 718 hr
Monthly Mean = 0.09
Mean Low = -0.40
Mean High = 0.60
Mean Range = 1.00

Table 6: Water Levels, m NGVD

		Jan 1989			
Day	Mid-Cycle Time	Low	High	Mean	Range
1	612	-0.12	0.48	0.20	0.60
1	1837	-0.11	0.56	0.21	0.67
2	703	-0.03	0.82	0.36	0.85
2	1928	-0.21	0.47	0.16	0.68
3	753	-0.16	0.70	0.26	0.86
3	2018	-0.20	0.63	0.20	0.83
4	843	0.08	0.90	0.48	0.82
4	2109	-0.15	0.96	0.29	1.11
5	934	-0.20	0.98	0.36	1.18
5	2159	-0.51	0.54	0.03	1.04
6	1024	-0.44	0.82	0.18	1.26
6	2249	-0.31	0.77	0.18	1.08
7	1115	-0.28	1.06	0.37	1.34
7	2340	-0.31	0.84	0.25	1.15
8	1205	-0.39	1.08	0.33	1.47
9	30	-0.50	0.67	0.08	1.17
9	1255	-0.61	0.86	0.12	1.47
10	121	-0.67	0.55	-0.04	1.22
10	1346	-0.72	0.75	0.00	1.47
11	211	-0.66	0.52	-0.06	1.18
11	1436	-0.69	0.64	-0.04	1.33
12	301	-0.48	0.61	0.08	1.09
12	1527	-0.58	0.70	0.04	1.28
13	352	-0.51	0.61	0.04	1.11
13	1617	-0.50	0.70	0.07	1.20
14	442	-0.51	0.75	0.07	1.26
14	1707	-0.57	0.35	-0.09	0.92
15	532	-0.46	0.56	0.03	1.02
15	1758	-0.52	0.37	-0.07	0.89
16	623	-0.36	0.60	0.12	0.96
16	1848	-0.41	0.43	0.02	0.84
17	713	-0.39	0.67	0.11	1.06
17	1938	-0.60	0.25	-0.15	0.85
18	804	-0.54	0.49	-0.03	1.03
18	2029	-0.54	0.28	-0.10	0.82
19	854	-0.43	0.62	0.10	1.05
19	2119	-0.48	0.37	-0.03	0.85
20	944	-0.49	0.70	0.11	1.19
20	2210	-0.44	0.48	0.05	0.92
21	1035	-0.45	0.83	0.20	1.27
21	2300	-0.62	0.43	-0.08	1.05
22	1125	-0.72	0.54	-0.09	1.25
22	2350	-0.54	0.35	-0.03	0.89
23	1216	-0.46	0.68	0.14	1.15
24	41	-0.40	0.62	0.12	1.02
24	1306	-0.45	0.70	0.11	1.15
25	131	-0.36	0.59	0.13	0.95
25	1356	-0.39	0.62	0.11	1.01
26	222	-0.20	0.59	0.20	0.79
26	1447	-0.31	0.64	0.16	0.95
27	312	-0.35	0.56	0.11	0.91
27	1537	-0.43	0.44	-0.02	0.87
28	402	-0.34	0.38	0.04	0.72
28	1628	-0.40	0.41	-0.02	0.81
29	453	-0.33	0.38	0.01	0.72
29	1718	-0.44	0.33	-0.09	0.77
30	543	-0.30	0.39	0.01	0.69
30	1808	-0.34	0.47	-0.02	0.81
31	634	-0.14	0.57	0.20	0.71
31	1859	-0.27	0.33	0.03	0.60

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Zeiss surveying system; a Zeiss Elta-2 first-order, self-recording electronic theodolite distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in December 1988 and the two surveys in January 1989 on profile line 188, located 517 m south of the pier. Changes included the development and repositioning of the nearshore bar (120 to 220 m) and the creation of an offshore bar (280 to 440 m) resulting in significant accretion seaward of the bar's crest (230 m).

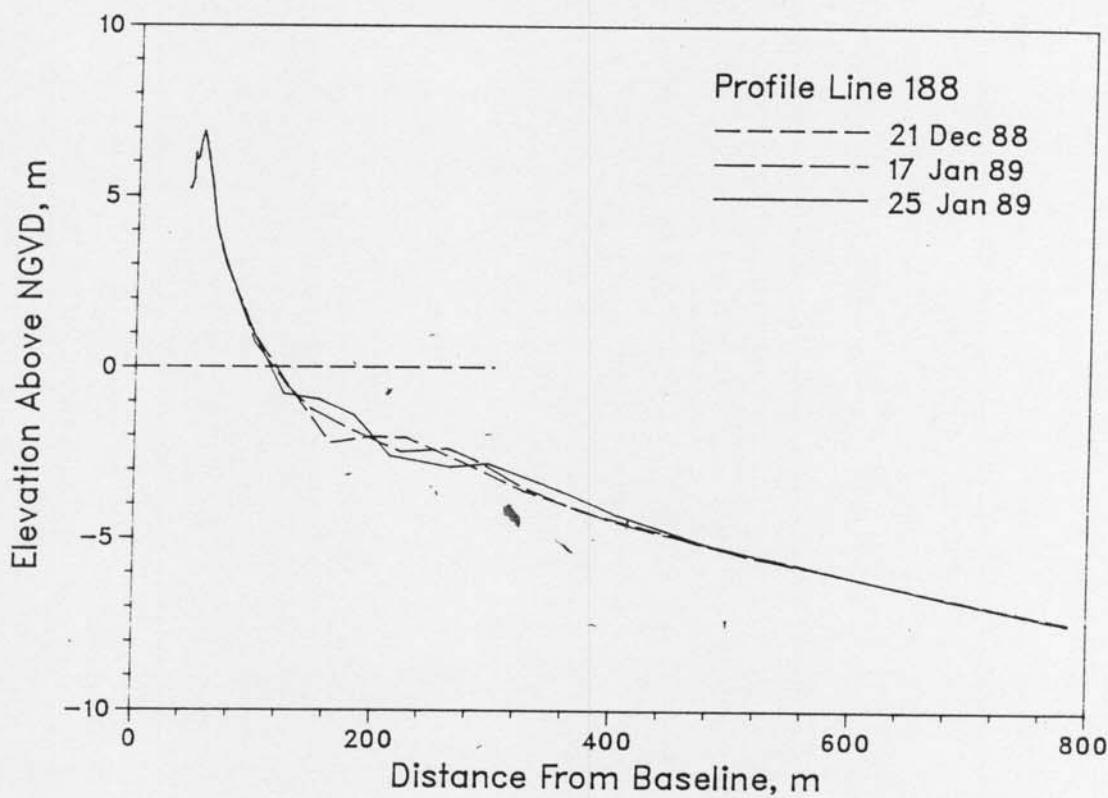


Figure 5. Monthly CRAB profiles on profile 188 -
517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1989.

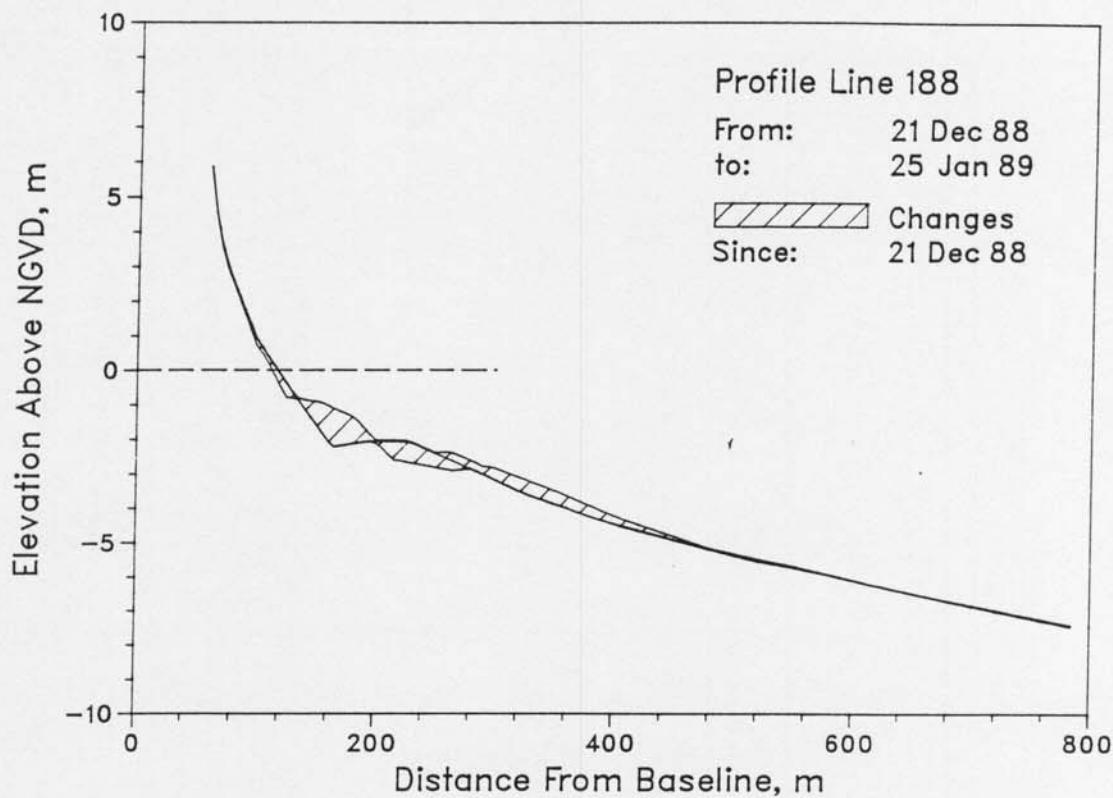


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey conducted on 25 January 89. Wide contour lines on the change diagram represent areas that eroded; thin lines indicate accretion.

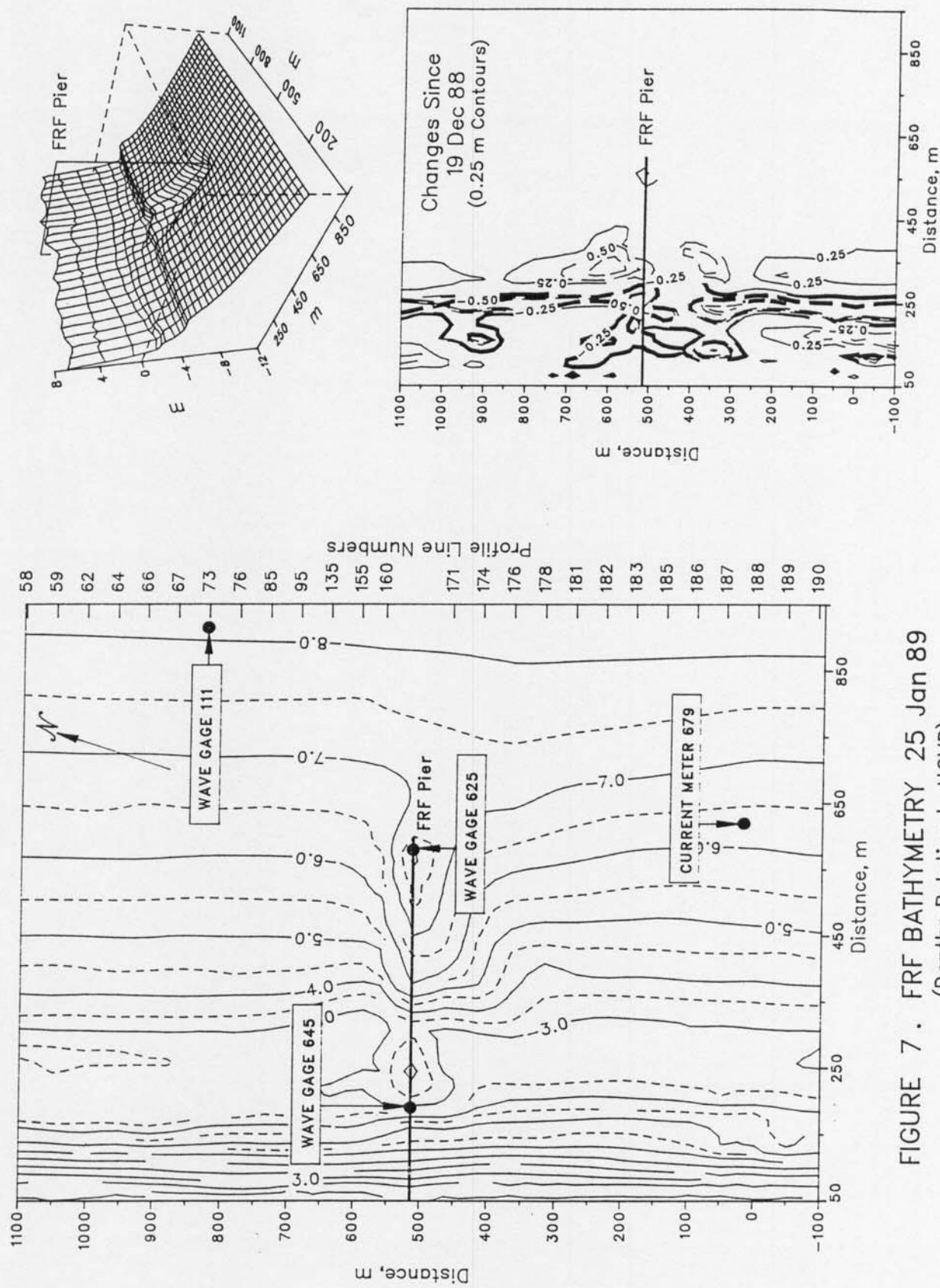


FIGURE 7 . FRF BATHYMETRY 25 Jan 89
(Depths Relative to NGVD)

PART VIII: SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when wave heights exceeded 2 m at the seaward end of the pier. When this occurred, four contiguous 34-min wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
4 Jan (0842)	4 Jan (1442)
23 Jan (0700)	24 Jan (1934)

B. Storm Synopsis.

4 January - Dropping down from Canada on 3 January, this storm quickly intensified as it passed over Virginia into the Atlantic. Maximum wind speeds (from northwest) exceeded 13 m/s on 4 January at 0242 EST, followed 6 hr later by the maximum H_{mo} (Gage 111) of 2.24 m ($T_p = 7.11$ sec). The minimum atmospheric pressure of 995 mb occurred on 3 January at 2042 EST. Precipitation totalled 5 mm.

23-24 January - On 20 January, this storm developed in the Gulf of Mexico and slowly moved across Florida into the Atlantic early on 23 January. Blocked by a New England high pressure system, the storm was unable to move up the coast and was forced into the open ocean. Maximum wind speeds (from north) exceeding 13 m/s were recorded on 23 January at 1334 EST. The maximum H_{mo} (Gage 111) of 3.08 m ($T_p = 10.67$ sec) occurred at 1600 EST. Because the storm tracked well south of the FRF the atmospheric pressure remained high dropping only to 1015.8 mb. There was no precipitation.

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